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Case Report

A Full Recovery after 52 Minutes of Uninterrupted Cardiac Arrest Utilizing Dual Sequential Defibrillation: Case Report and Review of the Literature

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Abstract

Refractory ventricular fibrillation is not an uncommon cardiac arrhythmia that is observed in patients with cardiac arrest. In this case, a 49-year-old male presented to the Emergency Department with an anterior ST-elevation myocardial infarction (STEMI). It began as a witnessed cardiac arrest with multiple rounds of unsuccessful standard defibrillation. The typical duration of CPR is approximately 20 minutes; however, with his O2 saturation at 98%, dual-sequential defibrillation (DSD) commenced, and after 52 minutes return of spontaneous circulation (ROSC) was obtained. Prior to this event, the longest ROSC recorded with a favorable outcome was 47 minutes. Currently, the ALCS is the gold standard for treatment during various cardiopulmonary emergencies, yet there is no guidance on refractory ventricular fibrillation. In these cases, multiple factors should be considered when determining whether or not to continue CPR. DSD is a promising treatment strategy to obtain ROSC, when the advanced cardiovascular life support (ALCS) protocol has been exhausted, and the O2 saturation levels have been maintained.

Keywords: Fibrillation, Refractory, Myocardial infarction, Ventricular, Saturation

ABBREVIATION

STEMI: ST-elevation myocardial infarction, **DSD**: Dual-sequential defibrillation, **ROSC**: Return of spontaneous circulation, **ALCS**: Advanced cardiovascular life support

INTRODUCTION

Cardiac arrest due to refractory ventricular fibrillation is seen in less than 4% of out-of-hospital cardiac arrests [1]. Currently, refractory ventricular fibrillation has multiple definitions ranging from failing to respond to two or more defibrillation attempts, to failing to respond to three or more defibrillation attempts after amiodarone has been exhausted. However, the main theme throughout all the definitions is the failure to respond to multiple defibrillation attempts [2]. ACLS protocols have provided guidance for multiple different cardiac arrest situations but fails to address the management of refractory ventricular fibrillation. Presented herein, is a case of refractory ventricular defibrillation utilizing a successful DSD, and a potential treatment strategy.

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CASE PRESENTATION

History of present illness (HPI)

A 49-year-old male reports to the ED, with a complaint of nausea, vomiting, profuse diaphoresis, and shortness of breath (SOB). The patient states that he woke up to get ready for work that morning and began to feel ill. He went to take a shower and immediately became nauseous. The patient then went to lay back down but became diaphoretic and cold. Prior to driving to the ED, the patient did report taking 4 baby aspirin 81mg by mouth. Once at the ED, the patient vomited, however denied chest pain, fever, cough, congestion, diarrhea, or dizziness. The patient reported a high caffeine intake as well as smoking one pack per day. The remainder of his history was noncontributory.

Emergency Department

An Electrocardiogram was performed with indications of a STEMI in leads V2-V6. Troponin was noted to be within normal limits upon arrival. Cath lab was activated. The patient then became unresponsive and a code blue, which is the common code color for a cardiac arrest within the hospital, was initiated at the time of 0628 (commonly referred to military or standard time, but dictates morning or night without the am or pm suffix). CPR commenced and the patient was noted to be in Pulseless Electrical Activity (PEA). An initial 1mg dose of Atropine was given, followed by 150mg dose of Succinylcholine, 300mg of Amiodarone, and a 1mg dose of Epinephrine. The patient converted between

Ventricular Tachycardia and Ventricular Fibrillation. Following intubation, a second dose of 150mg of Amiodarone per protocol, as was 1g dose of 10% Calcium Gluconate. Having no response, another 1mg dose of Epinephrine, along with a 100mg dose of Lidocaine was administered. Continuing with ACLS protocol a 1g dose of 4% Magnesium Sulfate, a 150mg dose of Amiodarone, a 50mEq dose of 8.4% Sodium Bicarbonate, a 4mg dose of Procainamide, and lastly a 50mEq dose of 8.4% Sodium Bicarbonate was administered. Throughout the administration of medications, the patient was defibrillated in accordance with ACLS protocol for a total of 12 attempts. Upon the arrival of the ER attending, the patient had a perfect waveform and the pulse oximeter registered an O2 saturation of 98%. It was noticed that the patient was in VFib. The code was still feasible as the patient had a viable pulse oximeter waveform and oxygen saturation. The patient's Arterial Blood Gas (ABG) **(Table 1)** and labs **(Table 2)** are shown. Based on the findings, another defibrillator was immediately requested to be brought into the room. The patient went through a total of 6 rounds of Dual Sequential Defibrillation and after the first 5 attempts, the patient's arrhythmia terminated for approximately 10-45 seconds and then reappeared. Finally, a 4mg dose of Procainamide and a 50mEq dose of 8.4% Sodium Bicarbonate was infused. Tissue Plasminogen Activator (tPA) in an IV bolus was infused non-protocol, to re-perfuse the coronary vessels. After 3 minutes of administering the tPA bolus, one more attempt of DSD was utilized, this had the effect to arrest the patient's VFib. ROSC was achieved at the time of 52 minutes post initiation of the code.

Cath Lab

Upon arrival at the Cath lab, the patient was noted to be in VFib and was Defibrillated a total of additional 35 attempts. Diagnostics showed the patient had a Mid-Left Anterior Descending Artery (LAD) total occlusion. The cardiologist placed a 3.0 x 16 mm drug-eluting stent into the LAD, leaving the patient with 0% stenosis. Of note there was a mild dilation to the left atrial and left ventricle chamber. Once the procedure was complete, the patient was stable and transferred to the Intensive care unit (ICU).

Table 1: Patient's ABG is shown.

	Patient Levels	Reference Range
Blood pH	7.462	7.35-7.45
PaCO2	38.4mmHg	35-45mmHg
PaO2	64.8mmHg	75-100mmHg
HCO3	26.8mEq/L	22-26mEq/L
O2 Content	28mL	16-20mL
O2 Saturation	91.1%	94-100%

Table 2: Here is the Patient's associated lab values that were taken immediately upon arrival to the ED.

	Patient levels	Reference Range
Magnesium	2.5 mEq/L	1.5- 2.0 mEq/L
Sodium	135 mEq/L	135-145 mEq/L
Potassium	3.8 mEq/L	3.5- 5.0 mEq/L
Total protein	5.5 g/dL	6.0- 7.8 g/dL
Albumin	2.8 g/dL	3.5 to 5.5 g/dL
ALT	166 U/L	8- 20 U/L
AST	365 U/L	8- 20 U/L
Anion gap	7 mmol/L	8- 16 mmol/L

ICU

Day 1, upon arrival at the ICU, the patient re-coded being defibrillated several more times. The patient remained intubated, sedated, and unconscious after the first several hours of arrival. The ICU physician ordered an Intra-aortic balloon pump (IABP). At 1310, the patient awoke. Day 2, the patient was extubated. The patient's blood pressure stabilized in the range of 80-90 systolic over 45-55 diastolic throughout the day. Day 3, the patient was transferred to a Telemetry unit. Day 5; post Myocardial infarction (MI), the need for a pacemaker was discussed and a dual defibrillator pacemaker was placed. During that procedure, the patient had another episode of V-Fib and required defibrillation. The procedure was successful and on Day 6, the patient was discharged home with follow-up instructions and appointments set up to start cardiac rehabilitation sessions.

Management and Outcome

The patient was discharged from the hospital with a diagnosis of ST-elevation myocardial infarction involving LAD, without end organ failure. His initial echocardiogram performed before pacemaker placement had shown a large area of apical dyskinesis, and a left-ventricular ejection fraction of 20-25%, mildly impaired left ventricular relaxation, mildly dilated left atrium, and minimal to mild regurgitation of the mitral and tricuspid valves. A month later, the patient had a follow up echocardiogram which showed an ejection fraction of 40%, apical dyskinesia, and anterior septal dyskinesia. Three months later, echocardiogram showed no change from the prior echo. The left ventricle was mildly dilated, and the left ventricle wall thickness was normal. He completed 36 sessions of cardiac rehabilitation over 3 months. He was cleared to return to work 5 months after his hospital stay with no restrictions. Eight months after the event, the patient's echocardiogram showed an ejection fraction of 45%.

The patient's medications: Apixaban 5mg twice daily (B.I.D.), Ivabradine 5mg B.I.D., Rosuvastatin 20mg daily (Q.D.), Clopidogrel 75mg Q.D., Furosemide 40mg Q.D., Aspirin 81 mg Q.D., Magnesium Oxide 400mg Q.D., Montelukast 10mg Q.D., Sacubitril/Valsartan 49/51 B.I.D., Metoprolol Succinate 25mg Q.D.

To date, the implantable defibrillator has not activated. The patient's ejection fraction has increased significantly from 20% from the initial echocardiogram to 45% on the echocardiogram performed eight months later. Although the ejection fraction is below normal limits (>50%), the patient's condition is stable with medications and he can perform his job as a firefighter with no restrictions.

Public Health

Surviving an in-hospital cardiac arrest can be dependent on both the patient's pre-existing conditions and the actions taken during the arrest. One must consider the recognition of the cardiac rhythm, total time of the resuscitation, and the patient's response to medications.

In a study involving 64,339 in-hospital cardiac arrests at multiple hospitals it was noted that 12,924 (20.1%) of rhythms had been VT or VF and 1,415 (79.9%) of rhythms were PEA or asystole. The median resuscitation duration for all patients was 17 minutes. It was also noted that 31,198 (48.5%) ultimately achieved ROSC. Patients that survived had a median resuscitation time of 12 minutes while efforts for non-survivors ceased at 20 minutes. Of the patients who achieved ROSC, only 9,912 (15.4%) survived to be discharged after having been in the hospital for a mean of 16.6 days. A Cerebral Performance Categories (CPC) assessment was completed on 8,724 of the survivors which showed 7,034 (80.6%) had a score less than or equal to 2. CPC assessment score did not change significantly based on resuscitation duration; however, longer resuscitation time did show a higher CPC assessment score [3].

The patient was a heavy coffee drinker. Caffeine works as an antagonist on adenosine receptors throughout the body, acting as a stimulant [4]. Because of this, tachycardias and arrhythmias, specifically noting VF, are common. The risk of a ventricular arrhythmia is increased due to decreased potassium in the plasma from caffeine stimulating the Na+/K+/ATPase protein [5]. Drinking 1-2 cups of coffee per day does not put one at risk. Cardiovascular disease is increased in non-coffee drinkers by 11%, decaffeinated coffee drinkers by 7%, and more than 6 cups of coffee per day by 22% [6].

Our patient was a night working firefighter. When comparing IL-6, WBC, neutrophils, lymphocytes, and platelets in a group of people on a schedule of three day shifts, one day off, then three night shifts versus a group of people with three night shifts, one day off, then three day shifts, all lab values were elevated when working the night shift [7]. Long term elevation of IL-6 overtime can lead to cardiovascular disease, inflammation, and fibrosis. Hypertrophy can also occur leading to a reduced contractile force [8]. High levels of WBC's, neutrophils, and lymphocytes increase coronary risk regardless of underlying heart disease [9].

These lifestyle choices contributed to the patient's heart disease. Fortunately, age and a workable cardiac rhythm aided in a favorable outcome. Many aspects attributed to this patient survival with no residual effects.

DISCUSSION/CONCLUSION

Currently, the usual duration for CPR is 20 minutes. The longest recorded in any case is 202 minutes and longest with eventual ROSC and favorable outcome is 47 minutes [10]. The patient presented in this case achieved ROSC with favorable conditions after 52 minutes of resuscitation, making this one of the longest recorded to date. There seems to be an arbitrary cut off for CPR duration, which may lead to more deaths. Contrary to popular practice, research has shown that there are other factors worth considering as well as the duration. In this case, the waveform and oxygen saturation were the key determinants used in accessing the patient's potential viability. This proved successful with the best possible outcome.

The contrast between this case and other cases was the incorporation of DSD. Studies have shown that dual defibrillation terminates 77% of Refractory VFib cases with full cerebral performance or mild disability [11]. The concern of utilizing DSD is the amount of energy produced. This value, while high (400J), does not amount to the maximum allowed which is up to 720J, rendering it safe and possibly more effective [12]. DSD is not officially approved, but we believe it should be considered. More research utilizing this modality should be published to create a database for comparison to the current protocol. There have been cases of patients receiving ROSC but not surviving to discharge [13]. Ultimately being able to calculate the risk/reward of this modality for Refractory V-Fib management may prove to be invaluable.

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